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Proceedings of the Regional Peer Review of the Assessment Framework for Atlantic Mackerel in subareas 3 and 4

January 18-20, 2017
Mont-Joli, Quebec

Chair: Dominique Gascon
Rapporteur: Sonia Dubé

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April 2017

Canada

Foreword

The purpose of these proceedings is to document the key activities and discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Appendices to the Proceedings.

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SUMMARY

This document contains the Proceedings of the Regional Peer Review of the Assessment Framework for Atlantic Mackerel in subareas 3 and 4. This meeting, which was held from January 18 to 20, 2017 at the Maurice Lamontagne Institute in Mont-Joli, gathered about 30 participants from DFO Science and Fisheries Management, as well as industry representatives, academics, provincial representatives and representatives from the National Oceanic and Atmospheric Administration (NOAA). These proceedings provide an overview of the key points of the presentations and discussions along with recommendations and conclusions presented during the review.

SOMMAIRE

Ce document renferme le compte rendu de l'examen régional par des pairs portant sur la révision du cadre d'évaluation du maquereau bleu des sous-régions 3 et 4. Cette rencontre, qui s'est déroulée du 18 au 20 janvier 2017 à l'Institut Maurice-Lamontagne à Mont-Joli, a réuni plus d'une trentaine de participants issus des sciences et de la gestion du MPO de même que des représentants de l'industrie, du milieu universitaire, des représentants provinciaux et du NOAA. Ce compte rendu contient l'essentiel des présentations et des discussions qui ont eu lieu pendant la réunion et fait état des recommandations et conclusions émises au moment de la revue.

INTRODUCTION

In the Maritime Provinces, Newfoundland and Quebec (NAFO subareas 3 and 4), several thousand commercial fishermen are involved in the Atlantic Mackerel fishery. This is primarily an inshore fishery in which gillnets, jiggers, handlines, seines and traps are used. The type of gear used varies by region and time of year. Canadian landings of Atlantic Mackerel are underestimated because some logbooks from the bait fishery are not filled out, and because direct sales at sea occur in this fishery. In addition, neither catches in the recreational fishery, which occur during summer months all along the Atlantic coast, nor discards of small mackerel are recorded. This issue of unrecorded catches has been raised on numerous occasions during previous assessments. Until we can better monitor fisheries data collection, the uncertainty regarding unrecorded catches can be taken into account using newly developed statistical models.

Until now, the abundance of Atlantic Mackerel has been assessed using sequential population analysis (SPA). This SPA is calibrated using an abundance index based on data from an egg survey conducted annually in the Southern Gulf of St. Lawrence. The most recent assessment of mackerel in subareas 3 and 4 was conducted in winter 2014. The software used for the SPA is now obsolete and no longer works on newer operating systems. In addition, it could not account for unrecorded catches.

The Fisheries and Aquaculture Management Branch has requested a Science Advisory Report on Atlantic Mackerel in Canadian waters for the 2017 and 2018 fishing seasons. In preparation for this assessment, it is important to develop a new population dynamics model in order to estimate the status of the resource. This statistical catch-age model must allow users to fully include the various sources of uncertainty, including estimated unrecorded catches and calculate reliable reference points. The purpose of this meeting is to review this new assessment framework for Atlantic Mackerel in subareas 3 and 4. Participants were invited to contribute to this review within the framework defined for it (Appendices 1, 2 and 3). This document contains the proceedings from the meeting that was held from January 18 to 20, 2017.

Day 1 – January 18, 2017

BACKGROUND

The meeting chair, Dominique Gascon, welcomed the participants. Mr. Gascon reviewed the objectives of the meeting and provided some procedural details. The participants introduced themselves.

Thomas Doniol-Valcroze, the biologist responsible for the assessment of the Atlantic Mackerel in subareas 3 and 4, started by providing background information on the stock and commercial fisheries, available scientific data and main issues. The most recent assessment of Atlantic Mackerel in subareas 3 and 4 was conducted in winter 2014, and the next review was scheduled for March 2017.

The biologist said it was a transboundary stock, meaning that some individuals born in Canada were caught in the US fishery. However, fish born in the United States do not contribute to the Canadian fishery. Large landings were recorded in the 1980s and from 2001 to 2010, followed by the very low current level. Newfoundland accounted for more than two-thirds of these landings (2001-2010).

Scientific data were mainly derived from an ichthyoplankton survey, which provided an estimate of the total number of eggs laid. This figure was used to back-calculate the spawning biomass

required to produce them. Sampling data (length-weight-growth, body condition, age, maturity, gonadosomatic index) were also used. Some environmental considerations, raised in the works of Plourde et al. (2015), should eventually be incorporated into the assessment. Additional surveys were conducted on the northeast coast of Newfoundland (3K) to verify whether there were other potential spawning sites, but none were found.

Mr. Doniol-Valcroze focused on the main issue affecting the quality of the assessment, unreported catches: mackerel used as bait for lobster and crab fishing, bait for personal use, sales between fishermen, recreational fishing and logbooks not filled in.

REVIEW OF THE ASSESSMENT FRAMEWORK

PREVIOUS MODELLING APPROACHES

The biologist provided a brief overview of the approaches used in previous assessments. Between 1986 and 2012, indices were mainly based on fishing data and data from an annual egg survey conducted in the Southern Gulf of St Lawrence. Between 2012 and 2014, the abundance of Atlantic Mackerel was assessed using sequential population analysis (SPA). This SPA was calibrated using an abundance index based on the egg survey. Natural mortality (M) for all age groups and years was set at 0.2 in the 2012 assessment. For the 2014 assessment, values of M were calculated using the relationship developed by Gislason et al. (2010). Results indicated scarcity and weakness in recruitment episodes since the 1980s, and very low recruitment since 2000. However, the high exploitation rate values appeared unrealistic. These assessments only used reported catches and were therefore suspected of underestimating the actual size of the stock. The ICA software used for the SPA is no longer supported by its developers and no longer works with today's operating systems.

- The egg survey was again confirmed to be a reliable indicator, as already discussed in the input review.
- According to participants, there was no evidence of Atlantic Mackerel eggs in the northern Gulf and northeastern Newfoundland (3K) based on current surveys.

ANALYSIS OF UNREPORTED CATCHES

Canadian Atlantic Mackerel landings were significantly underestimated due to unreported catches: fishing for bait for personal use or sold between fishermen, recreational fishing, discards of small mackerel and bycatch. In addition, there were significant differences between DFO management regions in how catches were recorded. Elisabeth Van Beveren's work attempted to estimate unreported catches. Ms. Van Beveren briefly presented the results from the literature and a survey. The results obtained by the two approaches were fairly consistent. Actual catches apparently represented at least 150% of reported catches. There is therefore a real need to adjust catches in the new model to include this uncertainty. These preliminary results will be used to provide information for "censored" versions of the new model.

Participants made a few comments:

- It was suggested that effort be considered rather than catches in the lobster fishery to assess the amount of bait used.
- Several participants, including many industry representatives, felt that information on unreported catches was incomplete and underestimated the actual situation. Other sources were available, particularly from industry. The estimate of small mackerel discards was also considered inaccurate and very relative (1.9%).

- It should be noted that this was a preliminary analysis, the purpose of which was to estimate a plausible maximum and that a lot of information still needed to be gathered. Participants were asked to submit any additional information.
- In addition, other unreported catches from US and foreign fisheries were mentioned. Some of the Atlantic Mackerel catches in subareas 5 and 6 should possibly be considered in subarea 3 and 4 stock assessments.
- In general, the analysis of unreported catches appeared to be conservative. However, since this was only an initial value for the catch limit, which can be updated as new data become available, this did not discredit the new model.

STRUCTURE OF THE CATCH-AGE MODEL

To address the uncertainty associated with missing catches, a relatively recent approach involves using so-called "censored" models in which reported catches are explicitly considered biased. The exact value of additional catches is unknown, but the available information is used, for example, to set lower and upper limits.

Ms. Van Beveren described the structure and components of the new model developed in Template Model Builder (TMB), an R software library that can quickly adjust complex nonlinear models that include random effects. TMB allows users to calculate the function to be optimized. This function is then optimized in R and can be used to estimate the metrics. All observation equations are on a logarithmic scale, and it is assumed that observation and process errors are distributed normally. It is a separable model using an annual F_y vector and partial recruitment (selectivity) at age F_a, which reduces the number of parameters to be estimated. Random variables are annual fishing mortality (F_y) and abundance (N_{ay}). The model uses the complete series of egg surveys (unlike the 2012 and 2014 assessments, which did not use egg data prior to 1996). Without the complete series, the new model cannot replicate historical abundance patterns, unlike the standard SPA, which uses backward calculation. Natural mortality (M) is set at 0.2.

Participants made a few comments:

- There was some question as to the value used for M. Some participants believed a relationship that varies mortality at age should be used, like the one used in the 2014 assessment (Gislason et al. 2010), with a higher M at the early stage.
- Some participants mentioned the possibility of including the survey directly as an egg production index and not as a spawning biomass index.
- It was pointed out that the upper limit (ceiling) could be adjusted if the missing catches were considered to be underestimated.

COMPARISON OF MODELS, DIAGNOSTICS AND PERFORMANCE

Three versions of the new model were explored: (1) no censorship, where the actual catch was assumed to be equal to the reported catch; (2) arbitrary censorship, where the upper catch limit was assumed to be 1.75 times the reported catch (based on the online survey); 3) informed censorship, where the upper limit of catches varied over time and was based on catch estimates for bait, recreational fishing and discards. A sensitivity analysis was also performed for each scenario censored for different upper-limit levels.

- Including uncertainty on unreported catches in the model did not change the age composition or our perception of fishing mortality.

- There were no particular patterns in the residues. The models seemed to fit well with the observation data, although the egg index was higher than the model's predictions for the years prior to 1995. Participants wondered about the possibility of external egg inputs or a change in catchability (q).
- After some discussions on the possibility of estimating q over two periods (given the change of ship and gear), participants agreed to work with a single q value since there was serious doubt that this affected the results.
- In general, censored models predicted catches that were higher than reported catches.
- However, biomass was underestimated before 1995. This may have been due to relatively high process and observation errors.
- It was noted that providing the model with additional flexibility by increasing the upper limit resulted in a better fit to the data.
- The participants again stressed the importance of providing the model with information regarding this upper limit.

It was difficult to compare the old analytical assessment model (ICA) with the new approach (TMB) because there were some basic differences between the models, and the ICA model could not be run again to perform a quantitative comparison. However, general reproductive biomass and fishing mortality trends were similar, and the conclusions regarding the stock trajectory were the same. Both censored and uncensored TMB models had a lower retrospective pattern than the ICA model.

- One of the problems in the previous assessment, based on the ICA model, was that reported catches represented a large percentage of the spawning biomass (up to 87%) for recent years. Considering the information on unreported catches, the censored approach seems more plausible.
- It was suggested to review the comparison of the ICA model and the TMB model, using the same relationship to calculate M (Gislason et al. 2010) as well as the series of egg surveys from 1996 onwards. This item was scheduled to be reviewed the next day. However, it was noted that the purpose of the meeting was not to compare these two models, but to assess the new model.
- Based on the comments at the meeting regarding the underestimation of unreported catches, it was suggested that the impact of increasing the ceiling be briefly assessed. This aspect was also to be discussed again the following day.

Day 2 – January 19, 2017

REVIEW OF THE NEW FIGURES

Comparison with the ICA model

Participants tried to better compare the two models by using the same parameters for the TMB model as those used in the ICA model during the 2014 assessment (e.g. M based on the relationship used by Gislason et al. 2010; series of egg surveys from 1996 onwards).

- However, it was difficult to interpret what was happening with the ICA model, because it was not clear what had been done. This model lacked transparency.
- The participants concluded that the models could not really be compared because they were structured differently.

- Thanks to Ms. Van Beveren's work, the new model gave users the option of a non-censored version and a censored version. As a result, it was not necessary to compare it with the old model.
- It was pointed out that the new model had the advantage of being transparent and flexible, and provided the option of including a censored version which quantified uncertainty on the missing catches.

Sensitivity to the choice of the upper value

Sensitivity to the choice of the upper value was reviewed using clearer figures.

- It was again noted that providing the model with additional flexibility by increasing the upper limit resulted in a better fit to the data.
- Choosing the right upper limit is therefore important, hence the need to provide the model with the most realistic information possible.

MODEL PARAMETERS

Partial recruitment

The fishing mortality was estimated by the model for early ages and was assumed to be constant for ages 6 and older.

- According to the participants, Atlantic Mackerel appeared to be fully recruited at a younger age.
- Participants therefore wondered about the possibility of setting a limit at a younger age (e.g. 4 to 5 years) and estimating changes in selectivity over time.
- It was agreed to conduct various trials, for example: setting the limit to 4 to 5 years; allowing the selectivity to vary over time.

Stock-recruitment relationship (S/R)

A Beverton-Holt stock-recruitment relationship including an environmental effect was used to model recruitment at age 1. This approach better reflected the year to year variability of recruitment, but did not explain high recruitment events.

- Participants wondered about the real usefulness of this relationship in the model. If this relationship were to be considered useful, should an environmental effect be included?
- It seemed that the stock-recruitment relationship was mainly used to determine reference points. However, other approaches could be used (e.g. study the frequency of events per block of time).
- For the time being, participants decided to retain the stock-recruitment relationship since it had little impact in the model. However, because it affected the determination of reference points, the approach would have to be rethought.
- To keep pace with the current trend, participants also kept the environmental effect which seemed to have little impact. A discussion within DFO should be held on how to consider the environmental effect in all stock assessments.

Natural mortality (M)

Participants reviewed the censored version of the model using the relationship developed by Gis!ason et al. (2010) to calculate M.

- The results differed from those obtained when M was set to 0.2. This effect nevertheless appeared remarkable.
- Participants wondered about the rationale for using an age-varying M (Gislason et al. 2010) in the 2014 assessment rather than a fixed M. After some research, it was found that this decision was apparently made during an input workshop presented in December 2013.
- It was therefore proposed to determine a vector of M that varied at age, but based on recent years (after 1999), which was more consistent with the current regime.

REFERENCE POINTS AND THE PRECAUTIONARY APPROACH

Mr. Doniol-Valcroze briefly presented three potential methods for determining the limit reference point (LRP), which were based on: 1) the stock-recruitment relationship; 2) the lowest biomass known to have recovered (B_{rec}); and 3) 40%B_{msy} using F40% as a proxy. It appeared that the stock-recruitment relationship was difficult to estimate when there were sporadic recruitment events, as was the case for mackerel. On the other hand, the B_{rec} method did not represent a conservative estimate of B_{lim} and was therefore not recommendable. F40% was a useful approach when the stock-recruitment relationship was unclear. In addition, this approach was based on the definition provided in the Canadian framework for the Precautionary Approach (DFO 2006). Regardless of the limit reference point selected, in 2013 the stock was in the critical zone.

- Participants seemed to prioritize the Canadian framework for the Precautionary Approach (40% Bmsy). Although other approaches could be assessed based on the sensitivity of the model, this approach was widely used and appeared sufficiently robust.
- The participants therefore agreed to determine the LRP based on F40%.

PROJECTIONS AND TAC

Two main questions were raised: How should projections be made? How should TACs be established?

- Given that unreported catches were included in the censored version of the model, participants wondered how TACs should be established based on projections.
- Projections should be viewed more as a potential catch (including unreported catches) than a commercial TAC.
- There was some question as to what should guide the choice of F for establishing the TAC. The average F (F = 8%) of the stable period (1968-1992) was used to recommend the TAC during the last assessment (2014). However, according to the participants, this F should be an option of last resort for the next assessment.
- Participants felt that it would be appropriate to present different F scenarios during the March 2017 assessment, in an attempt to select the most realistic input parameters possible.

Day 3 – Thursday, January 20, 2017

RECAPITULATION AND CONSENSUS

Participants took advantage of this last meeting day to review the key points in order to clearly identify areas of consensus.

USE OF THE TMB MODEL

Statistical validity

The participants seemed to be comfortable with the statistical validity of the model, which was deemed transparent and fitted well with the observational data. There was therefore consensus on the choice of the model. According to the participants, it represented a methodological improvement. Participants commented on the excellent work done.

Censored versus non-censored approach

At this stage, the participants were of the view that both approaches (censored and uncensored) should be retained. The results of these two approaches will be presented at the assessment meeting in March 2017.

Intuitive or time-varying ceiling based on new data as they become available

Participants decided to use a time-varying ceiling. This ceiling will be updated as new information on unreported catches becomes available. This approach was in line with a concern repeatedly raised by the participants, which was to provide the model with the most accurate information possible. Several stakeholders reiterated their interest in working together. In addition to unreported catches associated with bait fishing, recreational fishing, small fish discards and bycatch, it was again noted that unreported catches from US and foreign fisheries may need to be taken into account.

The participants recommended that various ceiling scenarios be presented at the next assessment meeting (March 2017) in order to identify the most plausible scenario.

MODEL PARAMETERIZATION

Natural mortality (M)

Participants agreed to recalculate M based on the relationship used by Gislason et al. (2010) for the recent period (after 1999), which was more consistent with the current regime. This M will be disaggregated by age but fixed in time: $M_{1\text{-}3} > M_{adult} = 0.2$.

Partial recruitment

Participants proposed setting full recruitment at 4 to 5 years and allowing selectivity to vary in the early years. It was also suggested that a trial be conducted in which selectivity varies over time.

S-R relationship

Although the stock-recruitment relationship would not be taken into account in setting reference points, the participants decided to keep the Beverton-Holt stock-recruitment relationship (with normal error distribution) in modelling, and include an environmental effect.

MODEL DEVELOPMENT

The following points were mentioned regarding development of the model:

- Discussion as to whether part of the US and foreign catches should be added;
- Adjusting the egg abundance index directly (versus Spawning Stock Biomass index);
- Lorenzen vector adjusted for M as an alternative to the Gislason method.

REFERENCE POINTS AND PROJECTIONS

Determining the LRP based on $F_{40\%}$

As already mentioned, the participants agreed to determine the LRP based on $F_{40\%}$. This approach was based on the Canadian framework for the Precautionary Approach (DFO 2006).

Projections

Regarding projections, it was agreed that different scenarios of F would be presented at the assessment meeting (March 2017) in an attempt to select the most realistic input parameters possible.

The meeting Chair thanked the participants and adjourned the meeting.

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APPENDIX 1- LIST OF PARTICIPANTS

Name	Affiliation
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Benchabane, Samir*	MAPAQ
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Gascon, Dominique	DFO Science
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Robert, Dominique**	UQAR
Roy, Virginie**	DFO Science
Van Beveren, Elisabeth	DFO Science

* present day 1 and 2 only
** present day 1 only

APPENDIX 2- TERMS OF REFERENCE

Review of the Assessment Framework for Atlantic mackerel in subareas 3 and 4

Regional Peer Review – Quebec Region

January 18-20, 2017
Mont-Joli (Quebec)

Chairperson: Dominique Gascon

Context

In the Maritime Provinces, in Newfoundland and in Quebec (NAFO subareas 3 and 4), over 15,000 commercial fishers participate in the Atlantic mackerel fishery. This fishery takes place mainly inshore using gillnets, jiggers, handlines, seines and traps. The type of gear used varies by region and time of year. Canadian landings of Atlantic mackerel are underestimated because some logbooks from the bait fishery are not filled out, and because direct sales at sea occur in this fishery. In addition, neither catches in the recreational fishery, which occurs during summer months all along the Atlantic coast, nor the discards of small mackerel are recorded. This issue of unrecorded catches has been raised on numerous occasions over the course of previous assessments. Until we can better monitor fisheries data collection, we can take into consideration the uncertainty regarding unrecorded catches using newly developed statistical models.

The abundance of Atlantic mackerel has been assessed until now using a sequential population analysis (SPA). This SPA is calibrated using an abundance index that is calculated based on data from an egg survey that takes place annually in the Southern Gulf of St. Lawrence. The last assessment of mackerel in subareas 3 and 4 was conducted in winter 2014. The software that was used for the SPA has become obsolete and no longer works on recent systems. In addition, it could not account for the unrecorded catches.

The Fisheries and Aquaculture Management Branch has requested a scientific advice on Atlantic mackerel in Canadian waters for the 2017 and 2018 fishing seasons. In preparation for this assessment, it is important to develop a new population dynamics model in order to estimate the status of the resource. This statistical catch-age model will need to be able to fully integrate the various sources of uncertainty, including the estimated unrecorded catches, and to allow for the calculation of robust reference points. The goal is to review this new assessment framework for Atlantic mackerel in subareas 3 and 4. The assessment of the Atlantic mackerel stock in subareas 3 and 4 is scheduled for March 2017.

Objectives

- Present the results of an online survey of fishers, and of an analysis of bait needs, in order to estimate an upper limit for undeclared catches used for bait;
- Select models to assess mackerel stock status and productivity in subareas 3 and 4, more specifically the stock size, catch at age composition and fishing mortality:
    - Identify a methodology that will allow us to estimate the unrecorded catch;
    - Assess the performance of models (with and without unrecorded catch) using diagnostics and sensitivity analyses (adjustment to data and residuals, retrospective analyses, sensitivity to main productivity parameters of stock);
- Determine methodology to characterize stock productivity including reference points for fishing mortality and spawning stock biomass and past, current and projected states relative to these points.

Expected publications

- 1 proceedings
- 2 research documents

Participation

- Fisheries and Oceans Canada (DFO) (Science and Fisheries Management sectors)
- NOAA Representatives / National Marine Fisheries Service, USA
- Industry representatives
- Provincial representatives
- Academics
- Aboriginal communities/organizations
- Environmental NGOs

APPENDIX 3- AGENDA

Review of the assessment framework for Atlantic mackerel in subareas 3-4

Regional Assessment Process Québec Region

January 18-20, 2017
Mont-Joli (Quebec)

Chairperson : Dominique Gascon

Day 1 - Wednesday, January 18, 2017

Time	Topic	Presenter
9:00	Introduction, objectives, terms of reference, and agenda	Dominique Gascon
9:30	Introduction : description of the stock and the fishery, scientific data, main issues	T. Doniol-Valcroze
10:15	*Break*	
10:30	Previous modeling approaches	T. Doniol-Valcroze
11:00	Analysis of unreported catches	Elisabeth van Beveren
12:00	*Lunch*	
13:00	Structure of catch-at-age model	Elisabeth van Beveren
13:45	Comparison of non-censored model with previous models	T. Doniol-Valcroze
14:30	*Break*	
14:45	Censored model	Elisabeth van Beveren
15:30	Diagnostics and performance	T. Doniol-Valcroze
16:30	End of day 1	

Day 2 - Thursday, January 19, 2017

Time	Topic	Presenter
9:00	Introduction and agenda	Dominique Gascon
9:15	Discussion on models	All
10:15	*Break*	
10:30	Discussion on models	All
12:00	*Lunch*	
13:00	Reference points and Precautionary approach	T. Doniol-Valcroze
14:00	Discussion on reference points	All
14:45	*Break*	
15:00	Discussion on reference points	All
16:30	End of day 2	

Day 3 - Friday, January 20, 2017

Time	Topic	Presenter
9:00	Introduction and recap of Day 2	Dominique Gascon
9:15	General discussion and choice of model framework	All
10:15	*Break*	
10:30	Recapitulation and conclusions	Dominique Gascon
11:30	End of meeting	